

THIS OPINION WAS NOT WRITTEN FOR PUBLICATION

The opinion in support of the decision being entered today
(1) was not written for publication in a law journal and
(2) is not binding precedent of the Board.

Paper No. 16

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE BOARD OF PATENT APPEALS
AND INTERFERENCES

Ex parte CHEN-HUA D. YU

Appeal No. 1997-3635
Application No. 08/498,357

ON BRIEF

Before FLEMING, BARRETT, and BARRY, **Administrative Patent
Judges.**

FLEMING, **Administrative Patent Judge.**

This is a decision on appeal from the rejection of claims
1 through 5, 8 through 12, 14 through 16, and 19. Claim 13
has been canceled. The rejection of claims 6, 7, 17, 18, and
20 is not appealed.

Appellant's invention is generally directed to a method
for forming a barrier metallization with low contact
resistance and in particular, to the protection of a barrier

metallization layer from oxidation. As disclosed on pages 8 and 9 of the specification, the surface of a barrier metallization layer is coated in-situ with a thin silicon layer prior to its removal from the reaction chamber. Additionally, the silicon layer may be sintered with the barrier layer to form a metal silicide which serves as a passivation layer as well as providing a low contact resistance to the underlying barrier layer. The disclosure on pages 16 through 18 teaches that any one of the Chemical Vapor Deposition (CVD) methods: Plasma Enhanced Chemical Vapor Deposition (PECVD) methods, and Physical Vapor Deposition (PVD) sputtering methods may be used for forming the barrier metallization and the silicon layers.

Representative independent claim 1 is reproduced as follows:

1. A method for forming a barrier metallization layer upon a semiconductor substrate comprising:

providing a semiconductor substrate;

forming upon the semiconductor substrate a barrier metallization layer; and

forming in-situ upon the barrier metallization layer a silicon layer, the silicon layer being formed without exposing the barrier metallization layer to oxygen, the silicon layer having a thickness such that the contact

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resistance of the barrier metallization layer is not substantially increased.

The Examiner relies on the following references:

Wong et al. (Wong)	4,873,204	Oct. 10, 1989
Yu et al. (Yu)	4,977,098	Dec. 11, 1990
Zhang	5,236,850	Aug. 17, 1993
Whitten et al. (Whitten)	5,451,811	Sep. 19, 1995
Sato (Japan '414)	04-63414	Feb. 28, 1992
(published Japanese Patent Application)		
Claims 1, 2, 4, 5, 9, 10, 12, 14, and 19 stand rejected		

under 35 U.S.C. § 102 as being anticipated by Wong. Claims 3, 8, 15, and 16 stand rejected under 35 U.S.C. § 103 over Wong. Claims 1 through 3, 5, 8, 9, 11, 12, 14, 16, and 19 stand rejected under 35 U.S.C. § 103 over Yu and Japan '414. Claims 11 and 20 stand rejected under 35 U.S.C. § 103 over Wong and Yu. Claim 6 stands rejected under 35 U.S.C. § 103 over Wong and Whitten. Claim 17 stands rejected under 35 U.S.C. § 103 over Wong, Yu, and Whitten. Claim 7 stands rejected under 35 U.S.C. § 103 over Wong and Zhang. Claim 18 stands rejected under 35 U.S.C. § 103 over Wong, Yu, and Zhang.

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Rather than repeat the arguments of Appellant and the Examiner, we make reference to the brief¹ and the answer² for the details thereof.

OPINION

After careful review of the evidence before us, we agree with the Examiner that claims 1, 2, 4, 5, 9, 10, 12, 14, and 19 are properly rejected as anticipated under 35 U.S.C. § 102. However, we reach the opposite conclusion with regard to the obviousness rejection of claims 1 through 3, 5, 8, 9, 11, 12, 14 through 16, and 19 under 35 U.S.C. § 103.

We note that Appellant does not respond in the brief to the Examiner's rejections of claims 6, 7, 11, 17, 18, and 20 under 35 U.S.C. § 103. In particular, the rejections are as follow: claims 11 and 20 are rejected under 35 U.S.C. § 103 over Wong and Yu; claim 6 is rejected under 35 U.S.C. § 103 over Wong and Whitten; claim 17 is rejected under 35 U.S.C. § 103 over

¹Appellant filed an appeal brief on August 5, 1996. Appellant also filed a reply brief on May 3, 2000, which included a correct copy of the claims.

²The Examiner mailed a supplemental answer on April 11, 2000, requiring a correct copy of the claims.

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Wong, Yu, and Whitten; claim 7 is rejected under 35 U.S.C. § 103 over Wong and Zhang; claim 18 is rejected under 35 U.S.C. § 103 over Wong, Yu, and Zhang. 37 CFR § 1.192(a) (July 1, 1996) **as amended at** 60 Fed. Reg. 14518 (March 17, 1995), which was controlling at the time of Appellant's filing the brief, states:

Appellant must, within two months from the date of the notice of appeal under § 1.191 or within the time allowed for reply to the action from which the appeal was taken, if such time is later, file a brief in triplicate. The brief must be accompanied by the fee set forth in § 1.17(c) and must set forth the authorities and arguments on which appellant will rely to maintain the appeal. Any arguments or authorities not included in the brief will be refused consideration by the Board of Patent Appeals and Interferences, unless good cause is shown [emphasis added].

Appellant did not include in the brief any arguments with regard to the above mentioned claims. We therefore, dismiss the appeal for rejection of claims 6, 7, 11, 17, 18, and 20 under 35 U.S.C. § 103.

Turning to the rejection of claims 1, 2, 4, 5, 9, 10, 12, 14, and 19 under 35 U.S.C. § 102(b) as anticipated by Wong, we note that Appellant on page 6 of the brief points out the

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groupings of the claims. 37 C.F.R. § 1.192(c)(7) (July 1, 1996) states:

For each ground of rejection which appellant contests and which applies to a group of two or more claims, the Board shall select a single claim from the group and shall decide the appeal as to the ground of rejection on the basis of that claim alone unless a statement is included that the claims of the group do not stand or fall together and, in the argument under paragraph (c)(8) of this section, appellant explains why the claims of the group are believed to be separately patentable. Merely pointing out differences in what the claims cover is not an argument as to why the claims are separately patentable.

Although Appellant has provided a statement regarding the grouping of the claims, Appellant has not in the arguments section of the brief provided separate arguments for the independent claims 1 and 14. We will, thereby, consider Appellant's claims 1, 2, 4, 5, 9, 10, 12, 14, and 19 as standing or falling together as a group and we will treat claim 1 as the representative claim of that group.

Appellant on page 7 of the brief argues that Wong does not preclude successive pump down cycles employing a single sputtering system or separate sputtering systems. Appellant adds that Wong therefore does not inherently disclose the claimed exclusion of oxygen and its effect on the resistance

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of the metal layer. Additionally, Appellant on page 8 of the brief argues that Wong teaches a low resistivity silicide but is silent with regard to the particular silicon layer thickness such that the contact resistance of the metal layer is not substantially increased.

The Examiner on page 6 of the answer responds to Appellant's arguments by stating that Wong's single pump down cycle precludes the presence of oxygen or other gases. The Examiner further states that other disclosed embodiments that may include more than one pump down cycle do not contradict the exclusion of oxygen in the single pump down cycle. Additionally, the Examiner points out that the claimed invention does not preclude an increase in the contact resistance but "only that the contact resistance is not substantially increased [emphasis is original]." The Examiner concludes that Wong's silicon film does not substantially increase the resistance of the metallization layer.

As pointed out by our reviewing court, we must first determine the scope of the claim. "[T]he name of the game is the claim." *In re Hiniker Co.*, 150 F.3d 1362, 1369, 47 USPQ2d 1523, 1529 (Fed. Cir. 1998). Claims will be given their

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broadest reasonable interpretation consistent with the specification, and limitation appearing in the specification are not to be read into the claims. ***In re Etter***, 756 F.2d 852, 858, 225 USPQ 1, 5 (Fed. Cir. 1985).

We note that Appellant's claim 1 recites

. . . forming upon the semiconductor substrate a barrier metallization layer; and
forming in-situ upon the barrier metallization layer a silicon layer, the silicon layer being formed without exposing the barrier metallization layer to oxygen, the silicon layer having a thickness such that the contact resistance of the barrier metallization layer is not substantially increased [emphasis added].

Appellant's claim 1, in addition to providing a semiconductor substrate, recites forming a barrier metallization layer and forming a silicon layer under specific conditions. These conditions include in-situ formation of the layers such that the barrier metallization layer is not exposed to oxygen. Additionally, the claim requires the silicon layer to have such a thickness that does not substantially increase the contact resistance of the barrier metallization layer. Therefore, we do not find that the claim precludes some increase in the contact resistance.

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A rejection for anticipation under section 102 requires that each and every limitation of the claimed invention be disclosed in a single prior art reference. *In re Paulsen*, 30 F.3d 1475, 1478-79, 31 USPQ2d 1671, 1673 (Fed. Cir. 1994), citing *In re Spada*, 911 F.2d 705, 708, 15 USPQ2d 1655, 1657 (Fed. Cir. 1990).

We find that Wong teaches a method of forming low resistance interconnects and contacts by sputter depositing an amorphous silicon layer over a refractory metal layer upon a semiconductor substrate. Wong in col. 3, lines 44 through 48, specifically discloses that:

The deposition of first the metal 26 and then the silicon 25 can be accomplished during a single pump down cycle in a sputtering system by providing both a metal target and a silicon target within the sputtering machine [emphasis added].

Therefore, Wong's sputtering system is pumped down once and uses the silicon and the metal targets within the machine to sequentially deposit the metal and silicon layers without breaking the vacuum. We find that such arrangement results in deposition of silicon over the barrier metallization layer without exposing the metal layer to ambient oxygen, as recited in Appellant's claim 1. Wong in col. 3, lines 58 through 66,

further discloses thermal annealing to convert the composite metal and silicon layer to low resistivity silicide. Additionally, Wong teaches in col. 6, lines 14 through 16 (patent claim 2), that the thickness of amorphous silicon is such that it is fully consumed in the reaction with the refractory metal. Therefore, Wong's silicon layer has a thickness which is small enough so that it does not substantially increase the contact resistance of the metal layer. We further point out the teachings of Wolf³ to buttress our findings with regard to Wong's single pump down cycle. Wolf on page 164 discloses a sequential sputter-deposition of refractory metal and amorphous silicon layers in one pump down, identical to Wong's process, to minimize the formation of an oxide on the metal layer. Wolf also limits the thickness of silicon layer such that the silicon reacts fully with the underlying metal layer. Therefore, Wolf supports our finding that Wong's single pump down sputtering forms the silicon layer without exposing the metal layer to oxygen, as recited in Appellant's claim 1. Additionally, we

³Wolf, Stanley, "Silicon Processing for the VLSI Era, Volume 2: Process Integration," 164-165 (Sunset Beach, CA, Lattice Press, 1990).

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find that Wong's silicon layer has a thickness such that the contact resistance of the barrier layer is not substantially increased as the silicon layer is fully consumed by reacting with the metal.

In view of the analysis above, we find that the Examiner has met the burden of providing a ***prima facie*** case of anticipation. We find that Wong teaches the formation of silicon and metal layers over a semiconductor substrate as recited in Appellant's independent claim 1. Accordingly, we affirm the rejection of claims 1, 2, 4, 5, 9, 10, 12, 14, and 19 under 35 U.S.C. § 102 over Wong.

Turning to the rejection of claims 3, 8, 15, and 16 under 35 U.S.C. § 103 over Wong, Appellant on pages 8 and 9 of the brief argues that the claimed thickness of metal and silicon layers have particular significance. Additionally, Appellant refers to different parts of the specification and points out the thickness of various layers in relation to the claimed thickness as specified for the metal and the silicon layers. In response, the Examiner argues on page 7 of the answer that

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Appellant has not provided any indication that the disclosed metal and silicon thicknesses are not conventional.

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The Examiner has failed to set forth a ***prima facie*** case. It is the burden of the Examiner to establish why one having ordinary skill in the art would have been led to the claimed invention by the express teachings or suggestions found in the prior art, or by implications contained in such teachings or suggestions. ***In re Sernaker***, 702 F.2d 989, 995, 217 USPQ 1, 6 (Fed. Cir. 1983). "Additionally, when determining obviousness, the claimed invention should be considered as a whole; there is no legally recognizable 'heart' of the invention." ***Para-Ordnance Mfg., Inc. v. SGS Importers Int'l, Inc.***, 73 F.3d 1085, 1087, 37 USPQ2d 1237, 1239 (Fed. Cir. 1995), ***cert. denied***, 117 S. Ct. 80 (1996) ***citing W.L. Gore & Assocs., Inc. v. Garlock, Inc.***, 721 F.2d 1540, 1548, 220 USPQ 303, 309 (Fed. Cir. 1983), ***cert. denied***, 469 U.S. 851 (1984).

We are not inclined to dispense with proof by evidence when the proposition at issue is not supported by a teaching in a prior art reference or shown to be common knowledge of unquestionable demonstration. Our reviewing court requires this evidence in order to establish a ***prima facie*** case. ***In re***

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Piasecki, 745 F.2d 1468, 1471-72, 223 USPQ 785, 787-88 (Fed. Cir. 1984); **In re Knapp-Monarch Co.**, 296 F.2d 230, 232, 132 USPQ 6, 8 (CCPA 1961); **In re Cofer**, 354 F.2d 664, 668, 148 USPQ 268, 271-72 (CCPA 1966). Furthermore, our reviewing court states in **Piasecki**, 745 F.2d at 1472, 223 USPQ at 788 (Fed. Cir. 1984) the following:

The Supreme Court in **Graham v. John Deere Co.**, 383 U.S. 1, 148 USPQ 459 (1966), focused on the procedural and evidentiary processes in reaching a conclusion under section 103. As adapted to **ex parte** procedure, **Graham** is interpreted as continuing to place the "burden of proof on the Patent Office which requires it to produce the factual basis for its rejection of an application under section 102 and 103" [**citing In re Warner**, 379 F.2d 1011, 1016, 154 USPQ 173, 177 (CCPA 1967)] [emphasis added].

After a review of Wong's disclosure, we fail to find any teachings related to the thickness of the metal and the silicon layers. We do not agree with the Examiner that the claimed thicknesses are conventional and obtained by merely changing the dimensions disclosed in the prior art. In this case, the prior art teaches the relative thicknesses but is silent with regard to the actual thickness of barrier metallization and the amorphous silicon. Therefore, Wong

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fails to provide any teachings related to different layer thicknesses such that one of ordinary skill in the art would have modified them in order to form the metal and the silicon layers having thicknesses as claimed by Appellant.

Accordingly, we reverse the rejection of claims 3, 8, 15, and 16 under 35 U.S.C. § 103 over Wong.

With regard to the rejection of claims 1 through 3, 5, 8, 9, 11, 12, 14, 16, and 19 under 35 U.S.C. § 103 over Yu and Japan '414, Appellant argues on pages 11 and 12 of the brief that neither reference suggests the combination. Appellant further points out that Japan '414 teaches a method for preventing surface oxidation whereas Yu discloses the formation of undesired native oxide layer during diffusion of impurities. Appellant concludes that Yu's diffusion step and the method disclosed by Japan '414 cannot be combined since they are related to oxide layers formed at different stages of processing. Appellant further argues that the combination of references does not teach a method for in-situ forming of a composite silicon and metal layer having low resistivity.

The Examiner responds to Appellant's arguments on page 7 of the answer by stating that the motivation for combining the

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references is derived from the need for avoiding native oxide formation and its removal in order to reduce the number of processing steps. The Examiner further argues that since Japan '414 teaches the benefits associated with absence of oxygen during process steps, one of ordinary skill in the art would have combined the references to avoid exposure to oxygen in Yu's process. Additionally, the Examiner asserts that, similar to arguments made with regard to Wong, the resistance of the metallization layer of Yu would not be increased by depositing the silicon layer.

The Federal Circuit states that "[t]he mere fact that the prior art may be modified in the manner suggested by the Examiner does not make the modification obvious unless the prior art suggested the desirability of the modification." ***In re Fritch***, 972 F.2d 1260, 1266 n.14, 23 USPQ2d 1780, 1783-84 n.14 (Fed. Cir. 1992), ***citing In re Gordon***, 733 F.2d 900, 902, 221 USPQ 1125, 1127 (Fed. Cir. 1984). The Federal Circuit reasons in ***Para-Ordnance Mfg. Inc. v. SGS Importers Int'l Inc.***, 73 F.3d 1085, 1088-89, 37 USPQ2d 1237, 1239-40 (Fed. Cir. 1995), ***cert. denied***, 519 U.S. 822 (1996), that for the determination of obviousness, the court must answer whether

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one of ordinary skill in the art who sets out to solve the problem and who had before him in his workshop the prior art, would have been reasonably expected to use the solution that is claimed by the Appellants.

We find that Yu teaches a process for forming multiple layers as the emitter diffusion source and the associated contact structure. Specifically, Yu in col. 4, line 52 through col. 5, line 6, discloses steps of forming titanium layer 120 and amorphous silicon layer 121 through amorphous silicon layer 116 upon a semiconductor substrate. Yu is concerned with removal of the undesired native oxide, formed over silicon layer 116 during the anneal and diffusion step, prior to the formation of titanium layer 120. However, we fail to find any particular teachings in Yu requiring particular conditions for depositing the silicon layer over the titanium layer to avoid oxidation of the metal layer.

Analyzing Japan '414, we find that a method and a device for processing semiconductor devices in a continuous state of reduced pressure are disclosed. Japan '414 specifically teaches a series of chambers with reduced pressure for

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performing different steps of processing. Therefore, we find that Japan '414 is generally concerned with preventing unwanted surface oxidation which eliminates the need for additional cleaning steps. However, we do not find any teachings or suggestions to prevent exposure of a metallization layer to oxygen, and in particular, in-situ deposition of a silicon layer over a metal layer.

We do not find any reason or suggestion to combine Yu and Japan '414 to form the silicon overlayer without exposing the barrier metallization layer to oxygen as recited in Appellant's claim 1. Although Japan '414 teaches process steps that prevent surface oxidation, Yu is silent with regard to the need for protecting the metallization layer from oxygen during the formation of amorphous silicon layer. Therefore, we do not agree with the Examiner that one of ordinary skill in the art would have combined Japan '414 teachings to avoid exposure of the metallization layer to oxygen.

We do not find that the Examiner has provided sufficient reason to combine Yu and Japan '414 to form the silicon layer without oxidizing the metal layer and substantially reducing its resistivity. We note that the other independent claim

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14 similarly recites the steps of forming the barrier metallization layer and in-situ forming a silicon layer without exposing the barrier layer to oxygen. Accordingly, we reverse the Examiner's rejection of claims 1 through 3, 5, 8, 9, 11, 12, 14, 16, and 19 under 35 U.S.C. § 103 over Yu and Japan '414.

In view of the forgoing, the decision of the Examiner rejecting claims 1, 2, 4, 5, 9, 10, 12, 14, and 19 under 35 U.S.C. § 102 is affirmed. The decision of the Examiner rejecting claims 1 through 3, 5, 8, 9, 11, 12, 14 through 16, and 19 under 35 U.S.C. § 103 is reversed. The appeal for rejection of claims 6, 7, 11, 17, 18, and 20 under 35 U.S.C. § 103 is dismissed. Accordingly, we affirm-in-part.

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No time period for taking any subsequent action in
connection with this appeal may be extended under 37 CFR
§ 1.136(a).

DISMISSED-IN-PART
AFFIRMED-IN-PART

LEE E. BARRETT)	
Administrative Patent Judge))
)	
)	
)	BOARD OF PATENT
MICHAEL R. FLEMING))
Administrative Patent Judge)	APPEALS AND
)	
)	INTERFERENCES
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MRF:hh

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